FOSSIL MICROTINES FROM LATE CENOZOIC DEPOSITS IN THE ANZA-BORREGO DESERT, CALIFORNIA, WITH THE DESCRIPTION OF A NEW SUBGENUS OF *SYNAPTOMYS*

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ABSTRACT: Remains of fossil microtines from the Late Cenozoic deposits of the Anza-Borrego desert are extremely rare. Microtines are found at only four out of 450 sites. The specimens found represent three genera: *Synaptomys, Microtus,* and an indeterminate one. The remains of *Synaptomys* when considered with similar forms described previously from Idaho and Kansas permit the naming of a new subgenus and species. The presence of the microtines adds credence to the suggestion of a more equable climate than at present in the area. The stage-of-evolution of the microtines confirms a Late Blancan to Irvingtonian time span for the deposits.

INTRODUCTION

Fossil-bearing deposits in the Anza-Borrego Desert of southern California have been recently described by Downs and White (1968). These deposits range in age from ?mid-Pliocene (Hemphillian) to mid-Pleistocene (Irvingtonian) and the fossils are arbitrarily placed into three local faunas. Over ninety vertebrate taxa have been reported, among which are three genera of microtine rodents.

The microtines are conspicuous in the deposits because of their extreme rarity. From 450 sites through 12,000 feet of beds, microtines are found at only four localities. This paucity may be ascribed to one or both of the following causes: 1. the southern location of the area; microtines are primarily boreal and temperate forms, and 2. the presence of the cricetine genera *Neotoma* and *Sigmodon,* which conservatively outnumber microtines in the deposits of this area some 100 to one and parallel them in dietary preferences. For example, Baker (1969) points out that *S. hispidus* is replacing *Pedomys ochrogaster* in the Recent fauna of the south-central states as the primary grass-eating rodent.

Unfortunately, not all the localities from which the microtines were obtained are in the type section, but rather from areas which have been subjected to an unknown amount of faulting. Consequently, exact stratigraphic relationships are difficult to determine. A detailed study of the geology of this region is presently underway. An attempt at correlation is based on the stage-of-evolution of the microtines. The nomenclature of the teeth follows Zakrzewski (1967).

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SYSTEMATIC PALEONTOLOGY

Synaptomys Baird 1857

Metaxyomys, subgen. nov.

Holotype.—Synaptomys vetus Wilson, 1933, Carnegie Inst. Wash. Publ. 440: 124–126, fig. 3. Specimen 1364 C.I.T. now in LACM.

Referred species:

Synaptomys landesi Hibbard, 1954, Jour. Mammal. 35, (n. 2): 249–252, Fig. 1C.

Synaptomys anzaensis, n. sp.

Subgeneric diagnosis.—The subgenus *Metaxyomys* is distinguished by its M_1 (Fig. 1A, B, I), in which the first and second alternating triangles are confluent as in the subgenus *Mictomys* (Fig. 1C), while the external re-entrant angles are well developed as in the subgenus *Synaptomys* (Fig. 1D).

Discussion and additional description.—The decision to place the species listed above into a new subgenus was based on the fact that these forms possess a number of characters which are intermediate between those found in the two extant subgenera, *Synaptomys* and *Mictomys.* Likewise, the subgenus, *Metaxyomys* combines characters which are now found independently in the two extant subgenera, as shown by the morphology of the M_1.

Cement may be present or absent in the posterior-external re-entrant angle of the M_1 in *Metaxyomys.* In *Mictomys* cement is absent in all the external re-entrants of the M_1. In *Synaptomys* it is present. The anterior loop of the M_1 is more vole-like in *Metaxyomys* than it is in either of the other two subgenera.

The third and fourth alternating triangles in the M_2 and M_3 of *Metaxyomys* resemble *Synaptomys* while the first and second alternating triangles are confluent as in *Mictomys.*

The upper molar teeth of *Metaxyomys* tend to more closely resemble those of *Mictomys* because of the slight development of a third internal re-entrant which helps to better isolate the most posterior triangle or loop (Fig. 1E–H). However, even in this character, some *Metaxyomys* specimens show an intermediate development between that of the two extant subgenera.

The capsular process for the reception of the lower incisor is located at the very anterior end of the M_3 in *Metaxyomys.* In *Synaptomys,* although a partial north-south cline has been demonstrated (Hibbard, 1963), the incisor terminates more posteriorly in every case and usually behind the M_3. In Recent specimens of *Mictomys* the incisor ends at the posterior portion of the M_2. One fossil species of *Mictomys, M. kansasensis,* has the lower incisor terminate behind the M_3 (Hibbard, 1952). The grooves on the upper incisors are apparently also intermediate in position, but approach more closely the position observed in *Synaptomys* (Wilson, 1933).

Etymology.—The subgenus *Metaxyomys* takes its name from the Greek *metaxy* = between, in allusion to its intermediate nature and *mys* for mouse.

Synaptomys (Metaxyomys) vetus Wilson

(Figures 1A, E)

Synaptomys vetus Wilson, 1933, Carnegie Inst. Wash. Publ. 440: 124–126, Figs. 2–3.

Holotype.—Same as type of subgenus.

Horizon and type locality.—Upper part of the Glenns Ferry Formation, early Pleistocene, Grand View local fauna, Owyhee County, Idaho.

Emended diagnosis.—*Synaptomys vetus* is distinguished by its M$_1$, on

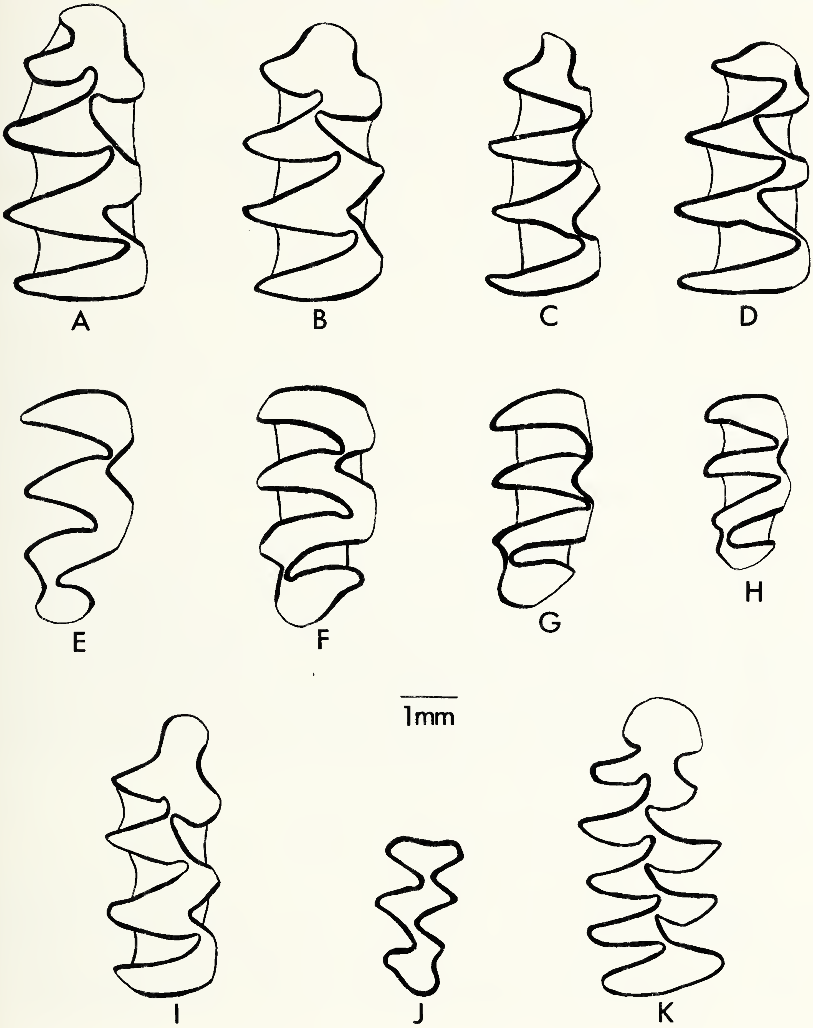

FIGURE 1. Occlusal views of microtine teeth. A-I, *Synaptomys*, A-D, RM$_1$s, E-H, RM^{3}s, A, *S.* (*Metaxomys*) *vetus*, UMMP V59973; B, *S.* (*M.*) *landesi*, UMMP V59982; C, *S.* (*Mictomys*) *borealis*, KU 43256; D, *S.* (*S.*) *cooperi*, KU 5041; E, *S.* (*Metaxomys*) *vetus*, UMMP V56322; F, *S.* (*M.*) *landesi*, UMMP V59972; G, *S.* (*Mictomys*) *borealis*, KU 43256; H, *S.* (*S.*) *cooperi*, KU 5041; I, *S.* (*Metaxomys*) *anzaensis*, *holotype*, LACM 19684; J, Microtine, *gen. et sp. indet.*, LACM 24647, LM^3; K, *Microtus californicus?*, LACM 24540, RM$_1$.

which the anterior loop generally possesses a deep, angular, internal re-entrant and a shallow, external re-entrant. The second alternating triangle of the M_1 is generally rounded in appearance. The M^3 has a posterior loop which is ellipsoidal in shape and lacks enamel along the entire posterior face.

Additional description.—Synaptomys vetus was chosen as the type of the subgenus because it is the best known member of the group. The M_1 is characterized by the first and second alternating triangles being confluent and having well-developed external re-entrant angles (Fig. 1A). The anterior loop appears to be generally smaller than those of other members of the subgenus. There is also a tendency for the internal re-entrant on the anterior loop of *S. vetus* to be more angular than in the other species and on occasion (5/22) this re-entrant is filled with cement. *S. vetus* is the only member of the subgenus in which this character has been found thus far. Cement is present in this re-entrant in the subgenus *Mictomys* but is lacking in the subgenus *Synaptomys*. The external re-entrant on the anterior loop of *S. vetus* is fairly shallow.

Generally the second alternating triangle appears rounded in outline (Fig. 1A) because of the flatness of the external surface due to the absence of enamel. On occasion (6/22), generally in ontogenetically younger specimens, the second alternating triangle is more triangular in nature. The triangularity of the second alternating triangle of M_1 is a character which predominates in *Synaptomys landesi* (Fig. 1B). Characters of the other lower molars will be considered under the discussion of *S. landesi*.

In the lower jaw of *Synaptomys vetus* and *S.* (S.) *cooperi* there is a ridge present between the tooth row and the ascending ramus. In *S. vetus,* a very shallow temporal fossa is found, exterior to this ridge on the ascending ramus, in a position approximate with the alveolar boundary between M_2 and M_3. An even less pronounced fossa occurs in *S. cooperi* in approximately the same position, while in *S. (Mictomys) borealis* the area between the tooth row and ascending ramus descends gradually to a deep point behind M_3. There is no obvious fossa or possibly the strengthening of the musculature, if any, occurs in the area behind the M_3. The condition which exists in the other species of the subgenus *Metaxyomys* is unknown. The ascending ramus of *S. vetus* thickens in the post-fossa area. The diastemal region appears to be more robust in the subgenus *Metaxyomys* than in either of the extant subgenera. The lower incisor of *S. vetus* terminates at the anterior edge of the M_3.

As mentioned above the posterior loop of the M^3 is very diagnostic in *Synaptomys vetus*. The loop is ellipsoidal in shape and enamel is absent from the entire posterior face (Fig. 1E). The first alternating and third alternating triangles open broadly into the second which is poorly developed to give a C-shaped pattern to the alternating triangles of the M^3. Characteristics of the other upper molars will be considered under the discussion of *S. landesi*.

Synaptomys (Metaxyomys) landesi Hibbard

(Figures 1B, F)

Synaptomys (Mictomys) cf. *S. (M.) vetus* Wilson. Hibbard, 1941, Kansas Geol. Surv Bull. 38, pt. 7: 213–214, pl. 2.

Synaptomys vetus Wilson. Hibbard, 1949, Bull. Geol. Soc. Amer. 60: 1424.

Synaptomys (*Synaptomys*) *landesi* Hibbard, 1954, Jour. Mammal. 35, (n. 2): 249–252, Fig. 1C.

Holotype.—UMMP V29961, fragmentary left ramus with M_1-M_3.

Horizon and type locality.—Type section of the Crooked Creek Formation, early Pleistocene, Borchers local fauna, Meade County, Kansas.

Emended diagnosis.—*Synaptomys landesi* is distinguished by its M_1, on which the anterior loop possesses a shallow internal and external re-entrant angle. The outline of the second alternating triangle of the M_1 is generally triangular in shape. The posterior loop of the M^3 is triangular in shape and the enamel is present along most of the posterior face. *S. landesi* appears to be slightly larger than the other members of the subgenus.

Additional description.—*Synaptomys landesi* has the first and second alternating triangles of the M_1 confluent, as do the other members of the subgenus. The second alternating triangle is closed off from the third. This closure was a character used by Hibbard (1954) to separate *S. landesi* from *S. vetus*. In the latter species the second triangle opened into the third. While this is true of some specimens, the majority of *S. vetus* specimens (19/22) also have these triangles closed. This variation in the degree of closure may be due to differences in the ontogenetic age of the individuals. The younger individuals show less closure. There is a tendency for the second alternating triangle of the M_1 in *S. landesi* to be more triangular in shape (Fig. 1B) than in the other species assigned to *Metaxyomys*, though there is some rounding exhibited in a few specimens (2/8).

Both of the re-entrants on the anterior loop are shallow. There is no evidence of cement in either of these re-entrants. From the sample on hand it appears that *Synaptomys landesi* is the largest of the three species (Fig. 2). This size difference is especially apparent in the height of the tooth.

The M_2 has the first and second alternating triangles confluent as in the subgenus *Mictomys*. The second triangle of *S. landesi* seems to be better developed, however. The third and fourth alternating triangles open broadly into each other, but the shape approaches more closely that of the subgenus *Synaptomys* for these triangles. The first external re-entrant of the M_2 in *S.*

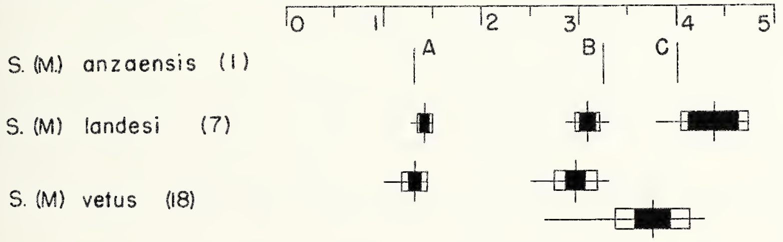

FIGURE 2. Bar diagrams showing variations in size parameters of *Synaptomys* (*Metaxomys*) M_1s. Vertical line represents the mean of the sample, the darkened area two standard errors of the mean, the white areas a standard deviation on either side of the mean, and the horizontal line the observed range. A, measurements (mm) of the width of the occlusal surface; B, length; and C, height of enamel crown. Size of sample is found in parentheses beside specific name.

landesi is short and broad as in *Mictomys*. The second external re-entrant is larger and more anteriorly directed than in either of the two Recent subgenera.

The M_3 of *Synaptomys landesi* resembles its M_2, in that the first and second alternating triangles resemble *Mictomys,* but are not as confluent, while the third and fourth alternating triangles more closely resemble *Synaptomys.* These M_2 and M_3 patterns do not differ significantly from those observed in *S. vetus.*

The characters of the lower jaw of *Synaptomys landesi* are largely unknown. The diastemal region is as robust and the incisor ends in the same position as in *S. vetus.*

The M^1 and M^2 of *Synaptomys landesi* resemble more closely those of the subgenus *Mictomys,* in that there is a slight development of an internal re-entrant angle near the posterior end of the teeth. The development of this re-entrant varies and in some cases is represented only by a shallow groove. These upper molars, likewise, do not differ significantly from those of the other two species of *Metaxyomys* except possibly in size.

Three M^3s of *Synaptomys landesi* are known. All three M^3s have the posterior loop shaped similarly to that of *Mictomys* but are not quite as angular (Fig. 1F). Enamel is absent from the posterior internal surface. The above two features readily distinguish *S. landesi* from *S. vetus.* In two of the M^3s, alternating triangles one and three open into two to give a C-shaped pattern. In the third tooth the middle external re-entrant nearly extends across the entire width of the tooth isolating the third alternating triangle. The first triangle still opens into the second.

Synaptomys (Metaxyomys) anzaensis, n. sp.

(Figure 1I)

Holotype.—LACM 19684, isolated RM_1.

Horizon and type locality.—Palm Springs Formation, probable middle Pleistocene, Vallecito Creek local fauna, San Diego County, California. loc. 6683.

Paratypes.—LACM 24539 RM^1, LACM 19071 $2RM^2$s.

Diagnosis.—*Synaptomys anzaensis* is distinguished from the other members of the genus by the shape of the anterior loop on the M_1, which is very vole-like and has deep internal and external re-entrant angles. The anterior loop is larger than that of other members of the genus examined.

Description of holotype.—The M_1 of *Synaptomys anzaensis* has the first and second alternating triangles confluent. The remaining connections between the loops and triangles are closed. The anterior loop is vole-like and relatively large when compared to other members of the genus. The re-entrant angles on the anterior loop are relatively deep but are rounded and lack cement. Cement is present in the remaining re-entrants of the tooth. The second and third internal re-entrants curve more forward than in *S. cooperi.* This feature appears to give the triangles a greater individuality than in the latter species. The external triangles of *S. anzaensis* are more rounded than those of *S. vetus* (Fig. 1I).

Etymology.—*Anza* from the Anza-Borrego Desert, *ensis* a suffix denoting a geographic location.

Description of paratypes.—These teeth have been characterized above in the discussions of the upper molars. They are not diagnostic enough, except possibly in size, to be separated from other members of the subgenus.

Discussion.—The lower jaw and M^3 of *Synaptomys anzaensis* are unknown at this time. I believe that if found their characteristics will be relatively close to those of the other members of the subgenus. To name a new species on the basis of so little material often presents problems, but the characteristics of the tooth, geographic separation of the localities, and the relatively large samples of the other members in the subgenus are sufficient to warrant this approach.

Relationships.—Because of the intermediate nature of the species which make up the *Metaxyomys* group it may appear that one or more could be ancestral to the extant subgenera of *Synaptomys.* The chief argument against this relationship is that good representatives of one extant subgenus are known from the fossil record prior to the first known appearance of *Metaxyomys.* This is *Synaptomys (Synaptomys) rinkeri* from the Dixon local fauna of Nebraskan age (Hibbard, 1956). The first known occurrence of the subgenus *Mictomys* is *Synaptomys* (M.) *meltoni* from the Cudahy fauna of Kansan age (Paulson, 1961). Faunas in which the subgenus *Metaxomys* is found are presently considered to be of Aftonian age (Hibbard, personal communication). If *Metaxyomys* types served as a common ancestor the divergence must have occurred some time in Pliocene time and the forms discussed above have carried on as a generalized type before becoming extinct.

Microtine, gen. and sp. indet.

(Figure 1J)

Material.—LACM 24647 RM^3; LACM 24648 $3M^1$s, $2M^2$s, 2 M_2s; loc. 1357.

Description.—The above specimens represent a small, primitive microtine with rooted teeth that lack cement in the re-entrant angles and have essentially no or only very slightly-developed dentine tracts. The M_2s possess the typical microtine pattern which consists of a posterior loop and four alternating triangles. The posterior loop is closed off from the alternating triangles. In one of the M_2s, considered to be a young adult individual, the first and second triangles open into each other, but are closed off from the third and fourth triangles which open into each other. These features impart a trilophed appearance to the tooth. The other M_2, in an adult stage of wear, shows a closure between the first and second alternating triangles. The enamel on the occlusal surface is very thick. There is no cement in the re-entrants and dentine tracts are essentially absent.

The M^1s of this species also possess the typical microtine pattern which consists of an anterior loop and four alternating triangles. The pattern most closely resembles that of *Pliophenacomys* from the Fox Canyon local fauna of Kansas (Hibbard, 1950). This similarity results from the development of a posterior internal re-entrant which isolates the fourth triangle from the third. An incipient "re-entrant pit" (Zakrzewski, 1969) is also present at the base of this re-entrant. There is also an incipient development of a re-entrant, or at least a slight depression, on the posterior external surface. There is a groove on the anterior face of the ontogenetically youngest specimen. The enamel is of equal thickness around the entire crown. Dentine tracts are incipient or very slight on the internal triangles and on the posterior face. Cement is absent from the re-entrants. The teeth are three rooted, with the medial-internal root being very reduced. The M^1s of this microtine approach *Ophiomys taylori* and the Fox Canyon *Pliophenacomys* in size. Microtine, gen. and sp. indet., differs from the former form because of the development of the posterior re-entrants, being slightly more hypsodont, having slightly better-developed dentine tracts, and a more reduced medial-internal root. It differs from the latter by the following characteristics: slightly more hypsodont; less-developed roots, especially the medial-internal; less-developed dentine tracts; and shallower internal re-entrants, with the exception of the most posterior one which is deeper.

The M^2s of Microtine, gen. and sp. indet., also resemble those of *Pliophenacomys* from the Fox Canyon local fauna. This similarity, again, results from the development of a posterior-internal re-entrant which tends to isolate the third alternating triangle. *Pliophenacomys* differs from the form under consideration in the following ways: *Pliophenacomys* is more robust for the size of the tooth; the enamel is thinner; the posterior-internal re-entrant is better developed which makes the third triangle more equilateral; it possesses a higher percentage of re-entrant pits; and the dentine tracts are slightly better developed. The M^2s of Microtine, gen. and sp. indet., also resemble that of a yet undescribed microtine in the collection of the University of Michigan Museum of Paleontology from the Sand Draw local fauna of Nebraska. The chief difference between the forms is that in the California specimens the posterior-internal re-entrant angle is deeper and the teeth have three roots, while the Nebraska specimen has only two roots.

In addition to the M_1, which is unfortunately missing in this case, the most diagnostic of the microtine teeth is the M^3. The M^3 of the microtine in question is characterized by an anterior loop, two alternating triangles and a posterior loop. The anterior loop opens slightly into the first triangle; the first triangle is confluent with the second; and the second triangle opens slightly into the posterior loop (Fig. 1J). The re-entrant angles are perpendicular except for the posterior-internal one which curves slightly back. The two anterior re-entrants are almost opposed. The enamel is very thick and equal around the entire tooth. Dentine tracts are absent. The tooth is two rooted. With the exception of the last character, the above description removes the California specimens from the genus *Pliophenacomys* which they resemble in the other upper molars. The M^3 of *Pliophenacomys* consists primarily of two lophs. The alternation of the triangles is not readily apparent. These features of the M^3 in *Pliophenacomys* were the chief reason why some microtines earlier placed in the genus were removed and the genus *Ophiomys* was erected for them (Hibbard and Zakrzewski, 1967). Though at about the same stage-of-evolution as some species of *Ophiomys*, the California specimens probably do not belong to that genus. The degree of confluency of the alternating triangles on the M^3 of the California specimen, along with the other characters of that tooth, suggests that another line of microtine is present. This line of reasoning is supported by the other molar teeth which morphologically appear closer to the *Pliophenacomys* line. The M^3 under discussion most closely resembles one belonging to a microtine from the Sand Draw local fauna. The Sand Draw M^3 was found at the locality mentioned above in the discussion of the M^2s. The two M^3s differ from each other only very slightly. Unfortunately for this study several genera and species of microtine are represented in the Sand Draw local fauna and not all of the specimens can be assigned properly because their remains are not associated. The two teeth from the Sand Draw discussed above are thought to be related to each other solely because of their morphological similarity to the Vallecito specimens, which by the laws of probability should represent one species. It might be mentioned here that the triangles on some young M^3 specimens of *Ophiomys taylori* approach the above teeth in degree of openness but are not as confluent, nor is the posterior internal re-entrant well developed. Possibly these microtines could have been derived from *Ophiomys* but they certainly represent a different line than the other species so far assigned to that genus. Only additional material will show the true relationship of this form.

Microtus californicus?

(Figure 1K)

Referred material.—LACM 24540 RM_1, loc. 6814; LACM 8252 RM_1, loc. 1942; LACM 24649 left edentulous lower jaw, loc. 6683.

Description of material.—LACM 24540 is an isolated RM_1 characterized by a posterior loop, five alternating triangles, and an anterior loop. The anterior loop can be considered to be composed of two additional alternating triangles and a small anterior loph (Fig. 1K). The posterior loop and the alternating triangles open very slightly into each other except on the anterior loop where the two triangles open broadly into the anterior loph. The enamel is differentiated into thin tracts on the posterior sides of the loops and triangles and thick tracts on the anterior edges, except on the anterior loop where the enamel is absent from the entire anterior face. Cement is present in all the re-entrants. The tooth is evergrowing. LACM 24540 measures 3.39 mm in length, 1.28 mm in width, and 4.72 mm in height.

The other M_1 (LACM 8252) is broken and still emplaced in a block of matrix. Only a portion of the anterior loop and 3 alternating triangles are visible. The tooth is assigned to *M. californicus?* for the following reasons: it is evergrowing, it has the enamel differentiated into thin and thick tracts, it has an anterior loop similar to LACM 24540, and it has cement in the re-entrants.

The lower jaw (LACM 24649) is assigned to *M. californicus?* because the alveolus for the M_1 shows that the tooth was evergrowing and of a type similar to LACM 24540 in terms of loops and alternating triangles. A relatively well-developed temporal fossa is also present. A similarly developed fossa is characteristic of the genus *Microtus* but is not found in *Synaptomys.* The latter genus is the only other microtine with evergrowing teeth present at this locality. However, it may be that the lower jaw represents another genus and/or species.

LACM 24540 in its stage of development, most closely resembles *Microtus californicus* among the Recent microtines. The fossil differs from the Recent forms chiefly in that the anterior loop is more rounded and the 6th alternating triangle is better developed. The fossil is larger than the specimens assigned to *M. californicus* in the collection of the Department of Biological Sciences, Fort Hays Kansas State College. The latter remains are thought to represent at least two and possibly three different subspecies on the basis of locality data with the specimens. The fossil is slightly smaller than the specimen of *M. c. aequivocatus* (UMMZ 79598) examined at the University of Michigan. It may be that the fossil represents a subspecies of *M. californicus.* It may also be that of a new species ancestral to extant *M. californicus.* But as the M_1 occlusal pattern of *Microtus* is highly variable it seems best to follow the above approach till more material becomes available.

PALEOECOLOGY AND AGE OF LOCALITIES

Microtines are generally found in boreal and/or relatively humid areas. This suggests that during the time the fossils lived the climate in the area of the Anza-Borrego Desert was more humid. Microtines are not found in this area at present. As the exact stratigraphic position of all the localities which contain microtines is not known (see discussion below), it cannot be stated with certainty whether the presence of the microtines coincides with an alternation of climate because of glaciation or whether other factors are involved.

All of the *Synaptomys* specimens and the edentulous *Microtus* lower jaw were found at loc. 6683. This might suggest that this locality was near a bog or marsh.

Downs and White (1968) compared the forms present in these deposits with the distribution in time of all known mammalian genera which have a fossil record in the late Pliocene and/or Pleistocene of North America. On the nature of the genera and their associations they arbitrarily divided the fossils in the superposed type section into three local faunas. The lowermost local fauna is the Layer Cake of early Blancan age, the middle local fauna is the Arroyo Seco of late Blancan age, and the uppermost local fauna is the Vallecito Creek of Irvingtonian age.

Loc. 1942, from which one of the RM_1s (LACM 8252) of *Microtus californicus?* is known, is the only locality of the four where microtines are found in the type section. Its position, 12,100 feet from the base of the section, places loc. 1942 in the Vallecito Creek local fauna. Savage (1951) assigned 2 RM_1s from the type Irvingtonian local fauna to *M. californicus.* This fact adds support for considering the Vallecito Creek l.f. to be of Irvingtonian age.

Loc. 6814 is not in the type section. A RM_1 of *Microtus californicus?* is found here. From the above discussion this locality is tentatively placed in the Vallecito Creek l.f.

Loc. 1357, where the remains of Microtine gen. and sp. indet. are found, is also not in the type section. The microtine from this locality appears to be most closely related to a species as yet undescribed from the Sand Draw local fauna of Nebraska. The Sand Draw l.f. is thought to be late Blancan in age. Hibbard (1970, footnote, p. 414) considers the Sand Draw l.f. to be Pleistocene, but to represent a time prior to continental glaciation. If a direct correlation can be assumed loc. 1357 would then be a part of the Arroyo Seco l.f. At present there is not enough evidence to substantiate whether or not this is indeed the case.

Loc. 6683, where the remains of *Synaptomys anzaensis* are found, is likewise not a part of the type section. The other species of *Synaptomys* assigned to the subgenus *Metaxyomys* are found in faunas considered Aftonian in age. The Borchers l.f. of Kansas is considered to represent an interglacial stage because of the nature of the fauna and was thought to be Yarmouthian because of its position above a volcanic ash (Hibbard, 1941). It has recently been suggested to Hibbard that the ash below the Borchers l.f. is not the Pearlette-like ash above the Cudahy l.f. He now considers the Borchers l.f. to be Aftonian in age (Hibbard, personal communication). Support for this thesis is the presence of some relict Pliocene species in the Borchers l.f. (*Sorex taylori, Perognathus pearlettensis, Etadonomys tiheni,* and *Hypolagus* sp.), and the better fit which would be obtained for the size chronocline in *Ondatra* demonstrated by Semken (1966). Hibbard is also working on a warm fauna from Ellsworth County, Kansas, which has an entirely different faunal complement from the Borchers, and is thought to be Yarmouthian on stratigraphic evidence. The Grand View l.f. of Idaho is correlated with the Borchers l.f. primarily on the stage-of-evolution of the *Synaptomys* and *Ondatra* which are known from both local faunas (Hibbard, 1959). Direct correlation on the basis of *Metaxyomys* would suggest an Aftonian age for loc. 6683. However, if the edentulous lower jaw of *Microtus californicus?* from loc. 6683 is correctly assigned, it may mean that *Metaxyomys* is a relict in California and this locality is of a younger age. Only more detailed work will enable us to know the true relationships of the deposits and contained faunas. The above discussion merely points out how scanty our information is and some of the possibilities one should be aware of.

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